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ABSTRACT

Partial and methodologically questionable replications of the Luria experiments on the child's verbal regulation of his motor behavior have led to results and conclusions contradictory to Luria's findings. An error in the methodology of two of these replications is discussed as the reason for a new investigation of Luria's hypothesis. Several experiments performed with children between 3 and 8 years of age are reported here. In general, data tend to support the hypothesis of a regulatory effect of the rhythmic aspect of speech over the simultaneous motor behavior of children from 3 1/2 years of age on. However, the results did not confirm predictions derived from the part of Luria's hypothesis concerning the possible regulatory function of the meaningful aspect of speech. (Author/ED)

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Investigation of the Regulatory Power of the Impulsive and Meaningful Aspects of Speech

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Talking to oneself may be useful in helping to achieve proper control over his own behavior. This has been intuitively known and practiced for centuries. However, a systematic study of the development of this function in the child had to await the pioneering work of the Soviet psychologist Luria in the late fifties and early sixties. According to Luria (1961), for children younger than three years, any combination of motor and verbal responses is difficult and of no controlling or regulatory value. In a second stage, between 3 and 4 years, a clear regulation of motor reactions is obtained when a verbal accompaniment, regardless of the meaning of the word employed, corresponds rhythmically to the motor task (this is the case, for example, when the child is required to say "go" while pressing a rubber bulb once, or "go, go" while pressing twice). In this case, Luria talks of an impulsive or rhythmic type of verbal regulation. With children between 3 and 4 years, however, as soon as the rhythmic correspondence between verbal and motor responses is removed, the child is no longer able to perform the motor task correctly (if, for example, he is to day "two" when asked to press the bulb twice for each light). By 5 years of age, the meaning of the verbal accompaniment begins to predominate over its rhythmic aspect so that if the two aspects come into conflict, the meaningful aspect predominates in mediating correct motor perfor-

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mance. Subsequent development consists of an increasing influence of speech in its meaningful aspect but no longer in the form of external speech, rather in the form of inner speech.

There have been few reproductions of Luria's experiments. Two (Jarvis, 1968; Miller, Shelton, & Flavell, 1970) carefully executed ones yielded contradictory results compared to those of Luria and led their authors to negative conclusions as to the regulatory power of the impulsive and meaningful aspects of speech. However, one aspect of the methodology used in these two works makes it difficult to admit them as valuable reproductions of the Soviet work. Indeed, Jarvis, as well as Miller et al. used very short intervals between stimuli in the tasks presented to children. In Jarvis' study, the mean interval was .78 second. The interval varied between 1 and 2 seconds in Miller et al.'s study. This seems very short when it is known (Fletcher, 1962) that the mean reaction time of an eight-year-old child to a visual stimulus in a choice condition is about .60 second. Such short intervals between stimuli may have made it difficult -- or impossible in a number of trials, at least in Jarvis' study -- to associate verbal and motor responses which virtually precluded verbal regulation.

The purpose of the experiments to be reported here was to correct for this technical error and so hopefully to supply an appropriate test of Luria's thesis. Several sets of experiments were performed with children between 3 and 8 years as well as with a group of adults; however, only some of the experiments performed with the children will be reported here.

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In a first set of experiments, 64 children from 3 to 7 years, described as developmentally normal, served as subjects. Subjects sat on a chair and were presented with visual stimuli (i.e., colored lights). The interval between lights varied randomly between 4 and 6 seconds while stimulus duraction varied randomly between 1 and 2 seconds. Motor response was squeezing a rubber bulb. The experimental session generally consisted of the following four successive tasks: Task A: motor response only; Task B: verbal response only; Task C: motor and verbal responses; Task D: motor response only, i.e., a repetition of task A.

In a first experiment, subjects were asked to press the bulb once for each light. The verbal response (in Task B and C) was "press." Table 1 (slide 1) summarizes the data in average percentages of Total Errors (TE) and different types of errors (Omissions -O- and extra bulb presses -ER-) in motor performance and in percentages of omissions of verbal responses -VO- in Task C, for children between 3 and 5 years. Task B (i.e., verbal response only) the results of which do not figure in Table 1 was performed with an average of 20% or fewer errors from age 3 on.

As can be seen from the table, there is a gradual decrease in total number of errors and different types of errors from younger to older subjects. The prediction that can be issued from Luria's hypothesis is that motor performance should be better when accompanied verbally (i.e. in Task C) than in silent condition. Such a trend is actually observed in the data (consider the average percentages of Total Errors in Task A and C for the different age groups). The differences in TE

between Tasks A and C are not very impressive, however, although it is significant (Wilcdxon Matched Pairs Signed-Ranks Test) for the group 3.6-4.0 years. It could be argued that the differences between Tasks A and C simply reflect additional training and increased familiarization with the tasks. This hypothesis has to be rejected, at least for the children between 3 and 4 years, on the basis of the results in Task D (consisting in a simple repetition of Task A). On Task D, for the two younger groups the results are very close to those obtained in Task A.

It is interesting to take a closer look at the age group (3.6-4.0 where a significant difference was found between Task C and Tasks A and D. The significant decrease in errors observed in this group appears to be due mainly to a decrease in extra bulb presses, i.e., in perseverative squeezing. These perseverative responses reappear in Task D where the subjects cease to accompany verbally their motor responses.

In a second experiment, subjects were asked to press the bulb twice for each light. The verbal response required in Tasks B and C was "press, press." Table 2 (slide 2) summarizes the data following the same organization as Table 1. The only difference is that instead of having one category for the omissions of motor responses, the table distinguishes between complete omission of MR (i.e., no press of the bulb), symbolized by OM and partial omission of MR (i.e., one press of the bulb) symbolized by PM. Task B (i.e., verbal response only) which does not figure on the Table was performed with an average of 20% errors or fewer from age 3 on. As showed in Table 2, a facilitative effect of VR on motor performance was generally observed. It reaches statistical

significance in age groups 3.6-4.0 and 4.0-4.6. The error analysis suggests that this effect was achieved mainly through a reduction of extra responses (ER) while omission percentages (OM and PM) remained unaffected by the presence of VR. A similar but less marked effect was also observed in group 4.6-5.0. For group 3.0-3.6, however, the situation is different. From Task A to Task C, the percentages of omission decrease markedly but an increase in extra responses is also observed suggesting that the young children were induced by the concommitant verbalization to press the bulb more than once and often could not stop responding after two presses.

So far, the verbal responses required from the subjects corresponded rhythmically to the motor responses. In a third experiment, subjects were asked to press the bulb twice for each light, as in experiment 2, but this time the verbal response (in Tasks B and C) was the word "two." This verbal response is related to the double press response only by its meaning, while its rhythmic structure (one verbal impulse) is in opposition to the rhythmic structure of the motor response. The results of the experiment showed that a monosyllabic verbal accompaniment not only failed to improve the double press performance but also exerts a negative influence on motor performance, particularly between 3 and 5 years, leading to an increase in the percentages of single presses. When the average percentages of Total Errors in motor performance are compared across Experiments 1 and 3 in Task C, significant differences are found in the age groups 3.6-4.0 and 4.0-4.6 in favor of the verbal accompaniment "press, press."

Concluding from the three experiments reported, it can be said:

1) For children between 3 and 3.6 years, the simultaneous production of verbal and motor responses led only to a slight and non-significant improvement in motor performance in Experiments 1 and 2.

2) For children between 3.6 and 5 years, combining verbal and motor responses led to marked (specially in Experiment 2) and often significant improvement in motor performance provided that verbal accompaniment corresponded rhythmically to motor responses. It must be noted that, with children between 3.6 to 5 years, the data are remarkably congruent to that reported by Luria. It must be asked why the same trend was not observed with children between 3 and 3 and a half. Two explanations can be considered: (a) the young child may be particularly limited in his motor abilities, i.e. he may not be able to perform in a better way on the motor tasks whether the experimental condition is silence or verbal accompaniment, or (b) his own verbalizations may still be deficient in regulating ongoing motor behavior. Additional experiments, not to be reported here, were performed with the younger children. They suggest that the second explanation is more likely to be the correct one which is congruent with Luria's developmental model. Indeed, once provided with an external and nonverbal means of controlling motor behavior, the younger children were all able to improve significantly the level of their motor performance.

3) For children older than 5 years, it appears that the motor tasks proposed were generally too simple, i.e. the performance on Task A was already too good as to allow further improvement. Thus, the

tasks used did not supply the expected basis on which to test the transfer of the regulatory power of speech from a rhythmic to a meaningful aspect that according to Luria is supposed to occur around 5 years. In order to test this transfer hypothesis, other experiments were performed with children between 5 and 8 years, in which more complicated motor tasks were presented. For time reasons, only one of these experiments will be reported. This will give a fair idea of the type of data obtained in this part of the whole research. Subjects were asked to make a strong press of the bulb for each red light and a light press for each white light (see Table 3 - slide 3 - for the organization of this experiment). Silent motor performance constituted Task A. In Task B, subjects were asked to practice verbal response "strong" for each red light and verbal response "light" for each white light. Both responses were to be uttered in a natural way, i.e. without accent of intensity on "strong." In Task C, subjects had to make simultaneously the appropriate verbal and motor responses for each light. Task D consisted merely in a reproduction of Task A. In Task E, subjects were asked to practice the same verbal responses "strong" and "light" but this time "strong" had to be emitted with a strong accent of intensity whereas "light" had to be pronounced in a soft voice. In Task F, subjects had to produce simultaneously verbal responses (as in Task E) and motor responses.

If accompanying speech has a positive effect on simultaneous motor performance, the latter should be of a higher level on Task C and/or in Task F than in Tasks A and D, provided that motor performance is not already too good in Task A as to prevent further improvement and

provided that producing the required verbal responses and combining them with the motor responses does not make a problem. More interesting, and the true purpose of the experiment, is that if there occurs after 5 years a transfer of the regulatory power of speech from a rhythmic or impulsive aspect to a meaningful aspect, motor performance should be better in Task C than in Task F or at least equivalent. Verbal accompaniment in Task C is indeed of the meaningful type whereas an element of rhythm or intensity has been added in Task F.

Table 4 (slide 4) shows the average percentage of Total Errors before the red and the white stimulus in the different tasks. As can be seen from the table (comparing results in Tasks A and C), there is no indication that a verbal accompaniment meaningfully related to motor performance had a facilitative effect on the latter. A comparison between Task F and Tasks A, C and D, however, indicates that once an impulsive dimension was added to the verbal response this led to a remarkable and often significant improvement of motor performance in the age groups where this performance was improvable, i.e. between 5.6 and 7 years. It does not seem that the mere repetition of motor performance along the different tasks is in itself a sufficient explanation for the marked difference observed in Task F. Thus it would appear that the introduction of a verbal accompaniment which corresponds to the motor response only in terms of meaning and not in terms of rhythm fails to regulate the motor performance. On the other hand, the regulatory value of the impulsive or rhythmic aspect of verbal accompaniment has again been demonstrated.

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As a general conclusion and briefly summarized, it can be said that the data collected tend to support the hypothesis of a regulatory effect of speech in its impulsive or rhythmic aspect over motor behavior from three and a half years on. In this respect, the work presented here constitutes a confirmation of the data previously reported by Luria and collaborators. As to the possible regulatory function of speech in its meaningful aspect, however, where the correspondence between motor response and verbal response is independent of rhythm, no experimental support has been found for this hypothesis within the limits of the verbal and motor tasks presented, the experimental setting and model, and the age ranges of the subjects.

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Table 1

Experiment 1: Average Percentages of Total Errors and Different Types of Errors between Ages 3 and 5 Years

Ages	TASKS A			C				D			
	TE	O	ER	TE	O	ER	VO	TE	O	ER	
3.0-3.6	38	16	22	32	14	18	19	40	17	23	
3.6-4.0	32	12	20	18	10	8	9	34	12	22	TE: A-C* C-D*
4.0-4.6	22	10	12	14	10	4	9	14	10	4	
4.6-5.0	12	9	4	11	11	2	7	11	8	5	

Key: TE: total errors O: omission ER: extra bulb press
VO: omission of V.R.

NOTE: * $p < .05$.

** $p < .01$.

Table 2

Experiment 2: Average Percentages of Total Errors and Different Types of Errors Between Ages 3 and 5.6 Years

Ages	TASKS A				C					D				
	TE	OM	PM	ER	TE	OM	PM	ER	VO	TE	OM	PM	ER	
3.0-3.6	73	21	35	17	58	15	15	28	16	71	24	23	23	
3.6-4.0	69	12	19	38	32	10	14	8	7	72	20	17	35	TE: A-C* C-D*
4.0-4.6	49	8	9	32	28	10	8	10	7	45	12	8	25	TE: A-C* C-D*
4.6-5.0	38	9	9	20	25	5	9	11	6	30	7	10	13	
5.0-5.6	13	2	3	9	15	4	3	10	2	11	1	1	9	

Key: TE: total errors OM: omission of M.R. (i.e., no press of the bulb) PM: partial omission of M.R. (i.e., one press of the bulb) ER: extra bulb press VO: complete omission of V.R. (in task C only)

Table 3

Organization of Experiment 11

Tasks	Stimuli	Responses Verbal	Required Motor
A	Red Light (RL)	--	Strong Press (SP)
	White Light (WL)	--	Light Press (LP)
B	RL	"strong"	--
	WL	"light"	--
C	RL	"strong"	SP
	WL	"light"	LP
D	RL	--	SP
	WL	--	LP
E	RL	"STRONG"	--
	WL	"light" (mezza voce)	--
F	RL	"STRONG"	SP
	WL	"light" (mezza voce)	LP

Table 4

Experiment 11: Average Percentages of Errors before the Red and the White Stimulus

Ages	TASKS A R	A W	C R	C W	D R	D W	F R	F W	
5.6-6.0	75	53	81	48	80	52	60	31	W: A-F* D-F*
6.0-6.6	58	40	54	44	48	47	23	22	R: A-C* C-F* D-F*
6.6-7.0	54	57	44	45	47	41	22	15	R: A-F* C-F* D-F* W: C-F* D-F* A-F**
7.0-7.6	14	12	18	18	28	20	14	10	
7.6-8.0	20	19	25	18	13	24	19	11	

Key: R: red stimulus W: white stimulus